Structural Geotechnical Report

Box Culvert Replacement Project
Illinois Route (IL) 251 over Unnamed Ditch
Route: F.A.U. 5128
Section: 105BR-1
Winnebago County, Illinois
Existing Structure Numbers: 101-0009, 0010, 2001, and 2002
Proposed Structure Number: 101-2050
Contract Number: 64D70

Prepared for

Illinois Department of Transportation

IDOT PTB: 172-017

Project Design Engineer Team:
Knight Engineers & Architects

Geotechnical Consultant:
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March 24, 2016
First Revision: June 21, 2016
Second Revision: June 29, 2016

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Integrity | Quality | Reliability

June 29, 2016

Mr. Clay Shipley
Vice President
Knight E/A, Inc.
631 E. Boughton Road, #205
Bolingbrook, IL 60440

Structural Geotechnical Report
Box Culvert Replacement
IL 251 over Unnamed Ditch
IDOT PTB 172-017
Structure Number: 101-2050
County: Winnebago

Dear Mr. Shipley:

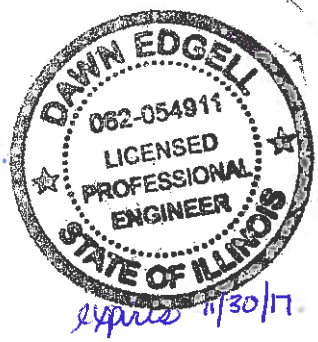
Attached is a copy of an abbreviated Structural Geotechnical Report for the above referenced project. This report provides a brief description of the site investigation, site conditions and foundation preparation recommendations. The site investigation was completed by IDOT in 2006 and included advancing five soil borings for the design and construction of the proposed culverts. The borings were drilled to depths of 36 to 61.5 feet near each of the existing culvert locations and were utilized for the proposed box culvert construction.

Should you have any questions or require additional information, please call us at 312-733-6262.

Sincerely,

Dawn Edgell

Dawn Edgell, P.E.
Senior Project Engineer



Expires 11/30/17

Ala E Sassila

Ala E Sassila, Ph.D., P.E.
Principal

Structural Geotechnical Report
Box Culvert Replacement Project
IL 251 over Unnamed Ditch
F.A.U. 5128
Section: 105BR-1
Winnebago County, Illinois
IDOT PTB: 172-017

Prepared by: _____
Edwin Flores, E.I.
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Approved by: _____
Ala E. Sassila Ph.D., P.E.
Principal

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Structural Geotechnical Report
Box Culvert Replacement Project
IL 251 over Unnamed Ditch
F.A.U. 5128
Section: 105BR-1
Winnebago County, Illinois
IDOT PTB: 172-017

1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed the geotechnical analysis and report for the design of a new precast concrete quadruple box culvert that will be replacing four existing culverts under IL 251 near Milford Avenue near Rockford, Illinois. The field investigation was completed by IDOT, and was provided to GSG. **Figure 1** shows the approximate locations of the proposed culvert.

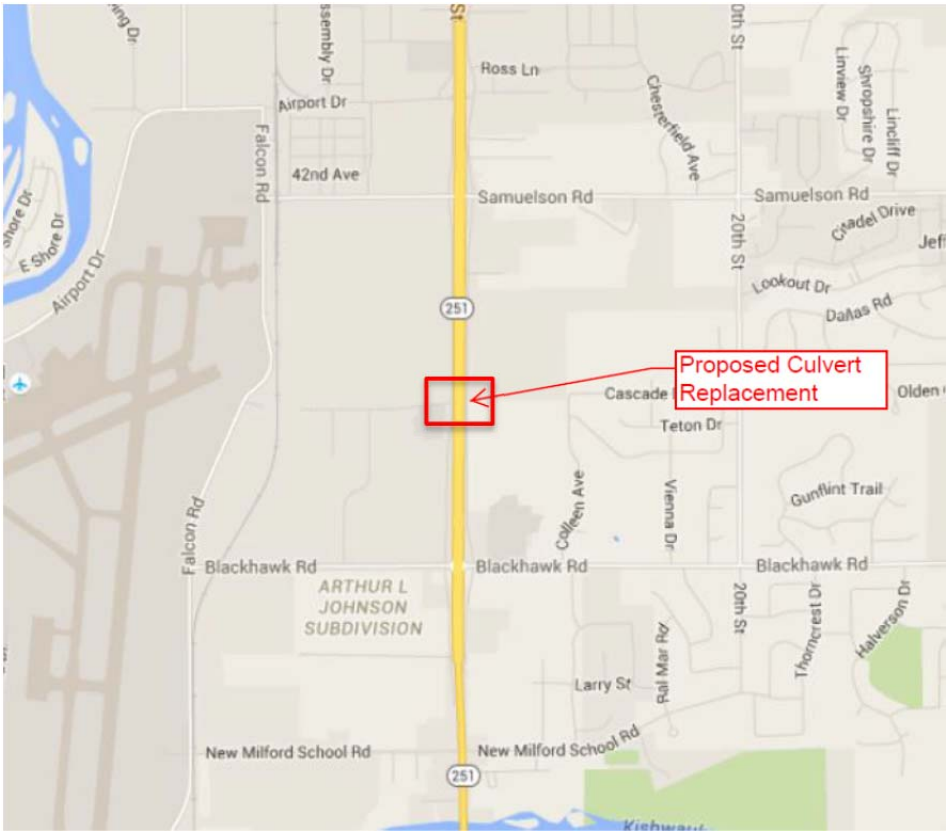

Figure 1: Project Location Map-Proposed Culvert Location

1.1 Project Information

The existing structures below IL 251 consist of 2 different structure types – either a reinforced concrete slab bridge or a three (3) celled reinforced concrete box culvert. The reinforced slab

bridges were originally constructed in 1951 and reconstructed in 1985. They are located below the center traffic lanes on IL 251. The existing box culverts are located under the outside traffic lanes, and were originally constructed in 1958.

Based on plan drawings provided by Knight E/A (dated March 2016), GSG understands that the replacement culvert will be constructed under IL 251 at Station 185+21. The proposed culvert under IL 251 will be 266 feet long and 52 feet wide with approximately 34 feet long wingwalls on each side. The overall structure will consist of four (4) 11-foot by 6-foot precast concrete box culverts placed next to each other, that will follow the same alignment as the existing culverts. Plans show that the proposed culvert will have an upstream invert elevation of 722.94 at the east end and a downstream invert elevation of 721.70 at the west end. The existing and proposed pavement elevations will match at most locations, with a few locations requiring minimal fill of up to 6 inches in the existing roadway area.

A general plan for the roadway improvements showing the proposed culverts was provided by Knight E/A, and has been included as **Appendix C – Culvert Design Plans.**

1.2 Existing Subsurface Information

GSG reviewed several published documents in an effort to determine the regional geological setting in the area of the site. The subject area is located in the south central portion of Winnebago County, Illinois. The surficial geologic deposits in this area are typically glacial drift deposited during the Illinois Glaciation. The subject area consists of deposits of silty clay till extending from the surface to more than eighty feet deep. Deposits are primarily from the Winnebago formation which consists of mostly diamicton with lenses of silt, sand and gravel. This formation overlies the Ordovician Galena Platteville Bedrock Formation which consists of brown and gray coarse grained dolomite with an average depth of 90 to 120 feet below ground surface in the subject area.

2.0 SUBSURFACE EXPLORATION

This section describes the subsurface exploration program completed as part of this project. The borings were completed by IDOT in 2006 and provided to GSG in January 2016. The locations of the soil borings are shown on the **Appendix C** - Culvert Design Plans (Knight E/A).

2.1 Subsurface Site Investigation

The subsurface investigation was conducted by IDOT between October 15th and 21st, 2006 and included advancing a total of five (5) standard penetration test (SPT) borings. **Table 1** presents a summary of the borings completed by IDOT for the new culvert.

Table 1 – Summary of Subsurface Exploration Borings

Soil Boring	Depth (ft)	Existing Ground Elevation* (feet)
B-1	36	731.3
B-2	58.6	731.1
B-3	43.8	729.3
B-4	42.5	725.2
B-5	32.5	725.5

* The elevations were converted from the crown elevations of the existing bridge provided by IDOT. The northbound crown elevation is approximately 731.7 feet and the southbound crown elevation is approximately 731.5 feet.

2.2 Subsurface Soil Conditions

The subsurface soil conditions were developed based on the results of the site investigation conducted by IDOT. Detailed descriptions of the subsurface soils, as well as the surface elevations, are included in the soil boring logs provided by IDOT. The soil boring logs provide specific conditions encountered at each boring location, including: soil descriptions, stratifications, penetration resistance, elevations, location of the samples, water levels (when encountered), and moisture test results. The stratifications shown on the boring logs represent the conditions only at the actual boring locations, and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

Boring B-1 was drilled in the existing pavement area while the remaining borings were performed in the vicinity of the existing structures outside of the pavement section.

Boring B-1 encountered 6 inches of asphalt at the surface. Below this layer at B-1 and below the existing ground surface at other boring locations, medium stiff to very stiff brown and black silty clay loam was encountered to depths of 8 feet. The silty clay loam layer was underlain by medium dense tan sand to a depth of 14.5 feet below grade. Borings B-2, B-3, and B-5 noted loose tan sand between depths of 5 to 11 feet below grade; boring B-4 noted very soft tan silt to a depth of 14 feet. The sand or the silt layer was underlain by medium stiff to very stiff tan silty clay and clay loam to a depth of 21 feet below grade and medium dense to dense tan sand with gravel to a depth of 29 feet. Following the sand layer, the borings noted very soft to medium stiff tan silt with sand to a depth of 32 feet, and loose to very dense gray and tan sand with gravel to the termination depths of between 36 to 60 feet.

In general, the cohesive materials encountered had unconfined compressive strengths ranging between 0.3 and 1.5 tsf and the granular materials encountered had SPT N values ranging from 8 to 70 blows per foot.

2.3 Groundwater Conditions

Water levels recorded on the soil boring logs provided by IDOT indicate that water was encountered in all the borings while drilling between elevation 693 and 699 feet. No water was encountered in any of the borings upon completion. Borings B-4 and B-5 noted a change in color of soils from brown to gray at elevations 691 feet and 665 feet respectively. The brown color of the soil is typically caused by oxidation that occurs above the long term water level. Based on this information, the long term groundwater elevation could not be determined at this time. In general, it should be noted that groundwater level may fluctuate based on seasonal precipitation, evaporation, surface run-off and other factors.

3.0 GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

This section provides GSG's geotechnical analysis and recommendations for the design of the proposed culverts based on the results of IDOT's field exploration, and GSG's geotechnical analysis.

3.1 Settlement

GSG estimated the anticipated settlement based on the proposed improvements for the replacement project. It is anticipated that minimal grading will be required to construct the proposed box culvert and the settlement after removal and replacement of the structures would be about 0.25 inch.

3.2 Seismic Considerations

The seismic hazard for the site was analyzed per the IDOT Geotechnical Manual, IDOT Bridge Design Manual, and AASHTO LRFD Bridge Design Specifications. As per the Bridge Manual, seismic data is not typically needed for buried structures.

The Seismic Soil Site Class was determined per the requirements of per Section 6.12.2.1.1 of the IDOT Geotechnical Manual, Seismic Site Class Definition Design Guide, and the "Seismic Site Class Determination" Excel spreadsheet provided by IDOT. A global Site Class Definition was determined for this project, and was found to be Soil Site Class D. The Seismic Performance Zone (SPZ) was determined using Table 6.12.2.1.3-1 in the IDOT Bridge Manual, and was found to be Seismic Performance Zone 1.

The AASHTO Seismic Design Parameters program was used to determine the peak ground acceleration coefficient (PGA), and the short (S_{DS}) and long (S_{D1}) period design spectral acceleration coefficients for each of the proposed structures. For this section of the project, the S_{DS} and the S_{D1} were determined using 2009 AASHTO Guide Specifications as shown in **Table 2**. Given the Seismic Performance Zone for this site, liquefaction is not a concern.

Table 2 – Seismic Parameters

Building Code Reference	PGA	S_{DS}	S_{D1}
2009 AASHTO Guide for LRFD Seismic Bridge Design	0.040g	0.135g	0.080g

3.3 Bearing Resistance

Based on the culvert design information provided by Knight, the proposed culvert will bear on 2 feet of Rock Fill, with invert elevations of between 721.7 feet and 722.94 feet. The plan drawings show wingwalls at each end of the culvert. The footings for these walls should be constructed independently of the box culvert. A foundation system consisting of shallow spread footings could be used to support the proposed culvert wingwalls and should be placed at a minimum depth of 3 feet below grade for Type L walls or 4 feet below finished grade for Type T Walls (in accordance with IDOT Culvert manual), for frost protection. Based on the design drawings provided, it is anticipated that cast-in-place apron end sections will be used. **Table 3** provides the nominal and factored bearing capacity in accordance with the latest version of the AASHTO LRFD manual. For the design of the foundations, the total live load and dead load, including the load of the overburden soils, should be considered. We recommend using a value of 120 pcf for the unit weight of the overburden material.

Table 3 – Recommended Bearing Resistance

Nominal Bearing (Strength Limit) (ksf)	Factor	Factored Resistance recommended for design (Strength Limit) (ksf)
6.04	0.45	2.72

The subgrade soils at the bearing grade should be evaluated for suitability prior to placing any portion of the proposed culvert structure and should be prepared as discussed in **Section 4 Construction Considerations** of this report. GSG anticipates undercuts of the very loose soils noted at the proposed bearing elevation in borings B-3 and B-5 in order to provide a stable working platform during construction. Undercuts of approximately 1.5 to 2.0 feet of the sands with N-values less than 3 could be necessary in these areas. The extent of the undercut should be field verified during construction activities. These undercut areas should be backfilled as discussed in **Section 4.2 Site Preparation** of this report. The undercut area should also be lined with a woven geotechnical fabric to assist with ground stabilization.

3.4 Lateral Design Pressures

Culvert wingwalls should be treated as retaining walls, and should be designed for all relevant LRFD strength and service limit states, and load combinations to resist and/or absorb lateral earth loads, vehicular loads, creep, and temperature and shrinkage deformations of the concrete box culvert. A traffic surcharge load of 250 psf, which is equivalent to 2 feet of soil,

should be used for the vehicular loads. The anticipated lateral pressure on the wingwalls was evaluated using Rankine earth pressure theory. Wingwalls that are attached, but independent of the box culverts, should be designed using an active earth pressure coefficient, Ka and additional soil parameters presented in **Table 4**. A unit weight of 120 pcf could be used for the backfill. The earth pressure coefficient may change if the backslope conditions are different. The backfill behind the wall should meet the requirements of the IDOT Standard Specifications for Road and Bridge Construction Section 209.

Table 4 – Lateral Load Design Parameters

Elevation (feet)	Soil Type	Unit Weight γ	Friction Angle ϕ	Passive Pressure Coefficient K_p	Active Pressure Coefficient K_a
	Proposed Granular Fill	120	30	3.00	0.33
	Proposed Cohesive Fill	120	20	2.00	0.49
Surface to 722	Medium Stiff to Stiff Brown Silty Clay Loam	130	26	2.56	0.39[+]
722 to 715	Medium Dense Brown Sand	130	32	3.25	0.31
720 to 717	Loose Tan Sand*	110	28	2.77	0.36
713 to 711	Very Soft Tan Silt**	115	27	2.66	0.38
714 to 708	Medium Stiff Tan Silty Clay	120	26	2.56	0.39
708 to 700	Medium Dense Tan Sand	130	32	3.3	0.31

* Soils encountered in borings B-3 and B-5

** Soils encountered in borings B-4

[+] Value based on a back slope angle of 10°

4.0 CONSTRUCTION CONSIDERATIONS

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Road and Bridge Construction (2012) and the IDOT Subgrade Stability Manual (2005). Any deviation from the requirements in the manuals above should be approved by the design engineer.

4.1 Stage Construction

Temporary Soil Retention Systems will be required at various stages of the construction for the proposed culverts and wingwalls if traffic is to be uninterrupted at the proposed locations. It is our understanding that staged construction will be utilized for the construction of the proposed improvements, which will allow traffic to be maintained during construction. This will require near vertical excavations along the centerline of the roadways to facilitate construction of the culverts. The Temporary Soil Retention Systems should include surcharge loads from the excavated materials, construction equipment, and trucks. The retention systems should extend to a sufficient depth below excavation bottom to provide the required lateral resistance for the design. Embedment depths should be determined based on the principles of force and moment equilibrium. The retention system should be designed for at-rest condition if the adjacent roadway section cannot withstand the anticipated horizontal and vertical movements of the construction excavation. The retention system shall be designed by an Illinois licensed structural engineer in accordance with the IDOT Bridge Design Manual.

Based on the anticipated conditions during the staged construction, GSG anticipates that sheet pile walls could be considered a viable option for temporary earth retention systems. Temporary sheet piling design charts from the IDOT Bridge Manual Section 3.13.1 may not be adequate for design as very soft silty clays and/or very loose granular soils were noted within the embedment depths. The soil parameters shown in **Table 4** and **Table 5** may be used for the design of the Temporary Soil Retention Systems.

Table 5 – Temporary Soil Retention System Design Data

Elevations (ft)	Soil Type	Dry Unit Weight (PCF)	Undrained Shear Strength (psf)	Undrained Friction Angle (°)	Drained Shear Strength (psf)	Drained Friction Angle (°)	Lateral Modulus of Subgrade Reaction k_0 (pci)	Soil Strain E_{50}
	Proposed Granular Fill	120	0	30	0	30	90	NA
	Proposed Cohesive Fill	120	1,500	25	75	25	500	0.007
Surface to 722	Medium Stiff to Stiff Brown Silty Clay Loam	130	800 - 2,000	0	50	26	100	0.01
722 to 715	Medium Dense Brown Sand	130	0	32	0	32	90	NA
720 to 717	Loose Tan Sand*	110	0	28	0	28	25	NA
713 to 711	Very Soft Tan Silt**	115	300	0	0	27	30	0.02
714 to 708	Medium Stiff Tan Silty Clay	120	700 – 1000	0	0	26	100	0.01
708 to 700	Medium Dense Tan Sand	130	0	32	0	32	90	NA
700 to 697	Very Soft Silt	115	300	0	0	27	30	0.02
697 to 690	Loose Tan Sand***	110	0	28	0	28	25	NA
690 to 661	Medium Dense to Dense Tan Sand	130	0	35	0	35	90	NA

* Soils encountered in borings B-3 and B-5

** Soils encountered in borings B-4

*** Soils encountered in borings B-2 to B-3

The selected earth retention system should also be designed for surcharge loading due to surface loads within the zone of the proposed backfill. Traffic loads are applicable only if the traffic lane is located parallel from the face of the wall within a distance equal or less than one-half of the wall height. At a minimum, a uniform vertical pressure of 250 psf should be considered in the design for traffic load. Other loads should be also evaluated using the procedures of AASHTO LRFD Section 3.11.6.

4.2 Site Preparation

All pavement materials, vegetation, surface topsoil, and debris should be cleared and stripped where new fill will be placed. Any unstable or unsuitable materials encountered during construction activities should be removed and replaced with compacted structural fill. Undercuts up to 18 inches should be backfilled with PGE consisting of IDOT gradation CA-7, CA-11 or CA-18 and undercuts with depths greater than 18 inches should be backfilled with rock fill (District 2) or IDOT gradation CA-1 crushed stone, and then be capped with 6 inches of PGE. The undercut area should also be lined with a woven geotechnical fabric, for ground stabilization. The culvert excavations should be backfilled in accordance with standard IDOT specifications.

4.3 Site Excavation

Site excavations are expected to encounter various types of soils as described in Section 2.2 Subsurface Exploration of this report. The contractor will be responsible to provide a safe excavation during the construction activities of the project. All excavations should be conducted in accordance with applicable federal, state, and local safety regulations, including, but not limited to the Occupational Safety and Health Administration (OSHA) excavation safety standards. Excavation stability and soil pressures on temporary shoring are dependent on soil conditions, depth of excavations, installation procedures, and the magnitude of any surcharge loads on the ground surface adjacent to the excavation. Excavations near existing structures and underground utilities should be performed with extreme care to avoid undermining existing structures. Excavations should not extend below the level of adjacent existing foundations or utilities unless underpinning or other support is installed. It is the responsibility of the contractor for field determinations of applicable conditions and providing adequate shoring for all excavation activities.

4.4 Borrow Material and Compaction Requirements

If borrow material is to be used for onsite construction, it should conform to Section 204 “Borrow and Furnish Excavations” of the IDOT Construction Manual (2012). The fill material should be free of organic matter and debris, and should be placed in lifts, and compacted in accordance with Section 205, Embankment, of the IDOT Construction Manual (IDOT, 2012). Earth-moving operations should

be avoided during excessively cold or wet weather to avoid freezing of softening subgrade soils. All backfill materials around the culvert must be pre-approved by the site engineer.

Undercut backfill for the culvert should consist of PGE per IDOT ABD Memo 11.3 and be placed in 8 inch loose lifts and be compacted by a vibratory roller.

4.5 Water Management

The proposed culvert project will entail replacing the existing culverts with a quadruple culvert. The existing culverts convey drainage water from the east side of the roadway to the west. During construction, the contractor will need to divert water away from the construction area, in an effort to keep the subgrade soils free of standing water.

The native soils in various locations within the project area were found to be poorly drained and moderately to highly frost susceptible. In some locations, these soil units may be saturated and significant water seepage may be encountered during excavation. This seepage will be temporary but there may be localized sloughing and near-surface instability of some soil slopes. The contractor should control groundwater and surface water infiltration to provide construction in dry condition. Temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment could be used to divert groundwater if significant seepage is encountered during construction. If water seepage occurs during construction or where wet conditions are encountered such that the water cannot be removed with conventional sumping, we recommend placing open grade stone similar to IDOT CA-7 to stabilize the bottom of the excavation below the water table. The CA-7 stone should be placed to 12 inches above the water table, in 8-inch lifts, and should be compacted with the use of a heavy smooth drum roller or heavy vibratory plate compactor until stable. The remaining portion of the excavations beneath the culverts should be backfilled using approved structural fill.

5.0 LIMITATIONS

This report has been prepared for the exclusive use of Knight E/A, its design team, and the Illinois Department of Transportation. The recommendations provided in the report are specific to the project described herein, and are based on the information obtained from the soil boring locations within the proposed project limits. The analyses have been performed and the recommendations have been provided in this report are based on subsurface conditions determined at the location of the borings. This report may not reflect all variations that may occur between boring locations or at some other time, the nature and extent of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations presented herein.

APPENDIX A

SOIL BORING LOGS

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/15/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 133+96
BORING NO. B-1
Station 134+18
Offset 12.0 ft Rt CL
Ground Surface Elev. 731.30 ft

Surface Water Elev. 724.50 ft
Stream Bed Elev. 724.50 ft
Groundwater Elev.:
First Encounter 699.3 ft ▼
Upon Completion Dry ft
After _____ **Hrs.** ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6" Asphalt				
				10
MEDIUM brown SANDY LOAM				
729.30				
MEDIUM tan LOAM with GRAVEL		3		
		2	0.8	9
727.80		3	P	
STIFF brown SANDY LOAM				
	-5	2		
		2	1.1	14
725.30		5	S	
MEDIUM brown SANDY LOAM		1		
		2	0.6	14
		4	S	
722.30				
MEDIUM tan clean medium coarse dry SAND	-10	2		
		5		
720.30		13		
		8		
MEDIUM tan fine SAND		9		
		10		
717.30				
STIFF tan SILTY CLAY	-15	1		
		3	1.2	23
715.30		4	B	
		2		
VERY STIFF tan CLAY LOAM with SILTY LOAM lens		3	2.1	23
		5	B	
712.30				
	-20	7		

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
MEDIUM tan dry clean medium coarse SAND *(continued)*		9		
710.30		12		
DENSE tan dry clean medium coarse SAND with GRAVEL		15		
		19		
707.80		26		
	-25	5		
MEDIUM tan fine SAND with moist SILT lens		10		
		11		
704.80				
MEDIUM tan SILT with SAND lens		5		
		5	0.6	22
702.80		6	B	
	-30	4		
VERY SOFT tan SILT		5	0.2	27
		8	P	
699.80				
	▼			
MEDIUM tan fine SAND		8		
		9		
697.80		12		
	-35	9		
MEDIUM tan fine SAND with medium SAND lens		12		
		13		
695.30				
End of Boring				
	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/15/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 133+96

BORING NO. B-2
Station 134+15
Offset 10.0 ft Lt CL
Ground Surface Elev. 731.10 ft

Surface Water Elev. ft
Stream Bed Elev. 723.80 ft

Groundwater Elev.:
First Encounter 699.1 ft ▼
Upon Completion ft
After Hrs. ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
MEDIUM black SILTY CLAY LOAM				
			0.8 P	15
	729.10			
VERY STIFF dark gray SILTY CLAY LOAM		2		
	728.10	3 5	2.3 B	21
VERY STIFF dark brown LOAM	-5	3		
		5 7	2.1 P	24
	725.10			
MEDIUM brown LOAM		1		
		3 5	0.9 B	21
	722.10			
LOOSE tan fine SAND	-10	3		
		2 3		
	719.60			
VERY STIFF tan SILTY CLAY with sine SAND lens		2		
	718.10	3 4	2.3 B	23
MEDIUM tan SILTY LOAM	-15	1		
		1 3	0.8 B	23
	715.10			
MEDIUM tan SILTY LOAM		1		
		2 2	0.8 S	24
	712.60			
	-20	3		
STIFF tan SILTY LOAM with fine SAND lens		6 8	1.8 S	14
	709.60			
MEDIUM tan dry clean medium coarse SAND with GRAVEL		6		
		12 17		
	707.10			
STIFF tan medium SAND with SILTY LOAM lens	-25	7		
		8 15	1.5 P	16
	705.10			
MEDIUM tan fine SAND with SILT lens		5		
		5 5		24
	702.10			
MEDIUM tan fine SAND with SILT lens	-30	2		
		5 8		
	700.10			
MEDIUM tan fine SAND ▼		11		
		14 15		
	697.60			
LOOSE tan fine SAND	-35	1		
		3 6		
	695.10			
LOOSE/MEDIUM tan clean medium coarse SAND with GRAVEL		1		
		3 7		
	692.60			
	-40	1		

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/15/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 133+96

BORING NO. B-2
Station 134+15
Offset 10.0 ft Lt CL
Ground Surface Elev. 731.10 ft

Surface Water Elev. ft
Stream Bed Elev. 723.80 ft

Groundwater Elev.:
First Encounter 699.1 ft ▼
Upon Completion ft
After Hrs. ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
DENSE tan fine SAND with medium GRAVEL *(continued)* 690.10		12 25		
End of Boring	-45 -50 -55 -60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/17/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 134+30

BORING NO. B-3
Station 134+30
Offset 31.0 ft Lt CL
Ground Surface Elev. 729.30 ft

Surface Water Elev. 723.00 ft
Stream Bed Elev. 722.50 ft

Groundwater Elev.:
First Encounter 696.8 ft ▼
Upon Completion Wash ft
After ____ **Hrs.** ____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				DRY tan LOAM
			9	
726.80				
	4			STIFF black SILTY CLAY LOAM
	5 7	1.9 B	18	
725.30				
-5				
	6			VERY STIFF black LOAM
	6 8	2.1 P	25	
722.80				
	3			MEDIUM brown SANDY LOAM
	3 5	0.6 S	13	
720.30				
-10				
	1			VERY SOFT tan dirty SAND with GRAVEL
	2 1	0.3 P	21	
717.30				
	3			MEDIUM tan dry fine SAND
	5 9			
714.80				
-15				
	5			MEDIUM tan SILTY CLAY with SAND lens
	3 3	0.7 P	24	
712.80				
	3			MEDIUM tan SILTY CLAY
	3 5	0.8 B	24	
710.30				
-20				

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	4			
	9 12	1.8 B	21	STIFF tan CLAY LOAM with clean medium SAND lens
707.30				
	3			MEDIUM tan dirty SAND & GRAVEL
	5 9			
705.30				
-25				
	6			MEDIUM tan fine SAND
	8 6			
702.30				
	0			SOFT tan SILTY LOAM
	1 3	0.3 B	25	
699.80				
-30				
	1			LOOSE tan moist fine SAND with SILTY LOAM
	3 5			
697.80				
▼				
	7			MEDIUM tan fine SAND
	8 12			
695.30				
-35				
	3			MEDIUM tan fine SAND
	5 6			
692.80				
	5			MEDIUM tan fine SAND
	9 13			
690.30				
-40				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/17/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO. _____
Station 134+30

BORING NO. B-3
Station 134+30
Offset 31.0 ft Lt CL
Ground Surface Elev. 729.30 ft

Surface Water Elev. 723.00 ft
Stream Bed Elev. 722.50 ft

Groundwater Elev.:
First Encounter 696.8 ft ▼
Upon Completion Wash ft
After _____ **Hrs.** _____ ft

		DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
DENSE tan SAND & GRAVEL			20 17 23		
	687.80				
DENSE tan SAND & GRAVEL			16 16 25		
	685.30	-45			
VERY DENSE tan clean medium coarse SAND with GRAVEL			13 100/7"		
	682.80				
Wash DENSE tan clean medium coarse SAND with GRAVEL	680.30		8 13 20		
		-50			
VERY DENSE tan clean medium coarse SAND with GRAVEL			1 26 27		
	677.80				
Wash VERY DENSE tan SAND & GRAVEL	675.30		19 36 34		
End of Boring		-55			
		-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/18/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 133+96
BORING NO. B-4
Station 133+67
Offset 44.5 ft Rt CL
Ground Surface Elev. 725.20 ft

Surface Water Elev. ft
Stream Bed Elev. 722.70 ft
Groundwater Elev.:
First Encounter 693.2 ft ▼
Upon Completion Wash ft
After Hrs. ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
MEDIUM brown LOAM				
			0.9 P	13
723.20				
STIFF brown LOAM		5		
		5 6	1.2 P	12
721.20				
MEDIUM brown fine SAND	-5	7		
		6 6		
719.20				
MEDIUM tan dry fine SAND		8		
		10 16		
716.70				
MEDIUM tan dry fine SAND	-10	8		
		8 10		
713.70				
SOFT tan SILT		2		
		1 4	0.3 P	27
711.70				
MEDIUM tan SILTY CLAY	-15	2		
		3 3	0.8 B	22
709.20				
STIFF tan SILTY CLAY with SAND lens		2		
		3 5	1.1 B	22
706.20				
	-20	18		
DENSE tan dry clean medium coarse SAND *(continued)*		25		
704.20		24		
MEDIUM tan fine SAND		5		
		12 14		
701.20				
SOFT tan SILT	-25	3		
		3 5	0.3 B	25
699.20				
MEDIUM tan SILT		2		
		4 8	0.3 B	23
696.70				
MEDIUM tan moist fine SAND with SILT lens	-30	6		
		7 12	0.4 P	22
694.20				
VERY STIFF tan CLAY LOAM with SAND lens ▼		7		
		6 7	2.7 B	23
691.20				
Wash	-35	2		
MEDIUM gray fine SAND		4 7		
689.20				
687.20				
	-40	4		

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/18/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 133+96

BORING NO. B-4
Station 133+67
Offset 44.5 ft Rt CL
Ground Surface Elev. 725.20 ft

Surface Water Elev. ft
Stream Bed Elev. 722.70 ft

Groundwater Elev.:
First Encounter 693.2 ft ▼
Upon Completion Wash ft
After Hrs. ft

		DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Wash			6		
MEDIUM tan fine SAND *(continued)*	684.20		15		
	682.20	-45	13		
VERY DENSE tan fine SAND with medium GRAVEL			18		
	679.20		36		
	676.70	-50	20		
VERY DENSE tan SAND & GRAVEL			25		
	674.20		30		
End of Boring		-55			
		-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 8/21/06

ROUTE FAU 5128 **DESCRIPTION** P92-121-07 Box culvert on West Frontage, IL 251, .5m. N. of Blackhawk Road **LOGGED BY** W. Garza

SECTION (105 BR-1, 105FB-1 & 105FB-2_ **LOCATION** Rockford Twp. - 13 NW, **SEC.** , **TWP.** 43N, **RNG.** 1E,
Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO.
Station 133+96

BORING NO. B-5
Station 133+64
Offset 35.0 ft Rt
Ground Surface Elev. 725.50 ft

Surface Water Elev. ft
Stream Bed Elev. 722.50 ft

Groundwater Elev.:
First Encounter 695.5 ft ▼
Upon Completion Wash ft
After Hrs. ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
STIFF brown LOAM				
			1.2 P	14
	723.00			
VERY STIFF brown LOAM		6		
		8 8	2.9 S	15
	721.50			
	-5			
SOFT brown SANDY LOAM with SAND lens		3		
		1 1	0.3 B	22
	719.00			
STIFF tan SILTY CLAY with SAND lens		3		
		3 5	1.5 P	21
	716.50			
	-10			
STIFF tan SILTY CLAY		1		
		2 4	1.0 S	24
	714.00			
STIFF tan SILTY CLAY		2		
		2 4	1.0 B	24
	711.00			
	-15			
MEDIUM tan dry fine SAND		5		
		11 18		
	709.00			
DENSE tan dry fine SAND		10		
		15 32		
	706.00			
	-20			

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
MEDIUM tan SILT		8		
		9 12	0.5 S	20
	703.50			
MEDIUM tan fine SAND with medium GRAVEL		11		
		13 16		
	701.00			
	-25			
SOFT tan SILT		4		
		6 5	0.3 B	22
	698.50			
MEDIUM tan fine moist SAND		5		
		8 11		
	696.50			
	▼-30			
MEDIUM tan fine SAND		2		
		7 12		
	694.00			
	691.50			
	-35			
MEDIUM tan medium SAND with fine SAND lens		10		
	689.00	7 26		
	686.50			
	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

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SOIL BORING LOG

Date 8/21/06

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Latitude , **Longitude**

COUNTY Winnebago **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME-45 Automatic

STRUCT. NO. _____
Station 133+96

BORING NO. B-5
Station 133+64
Offset 35.0 ft Rt
Ground Surface Elev. 725.50 ft

Surface Water Elev. _____ ft
Stream Bed Elev. 722.50 ft

Groundwater Elev.:
First Encounter 695.5 ft ▼
Upon Completion Wash ft
After _____ **Hrs.** _____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
MEDIUM tan fine SAND	9			Wash	4		
	10			MEDIUM light gray clean medium	8		
684.00	13			coarse SAND 664.00	17		
				End of Boring			
681.50							
-45 Wash				-65			
DENSE tan medium coarse	27						
SAND with GRAVEL	19						
679.00	15						
676.50							
-50				-70			
Wash	12						
DENSE tan fine SAND with	15						
GRAVEL	17						
674.00							
671.50							
-55				-75			
Wash	5						
MEDIUM tan fine SAND	11						
669.00	17						
666.50							
-60				-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, form 137 (Rev. 8-99)

APPENDIX B

CULVERT DESIGN PLANS

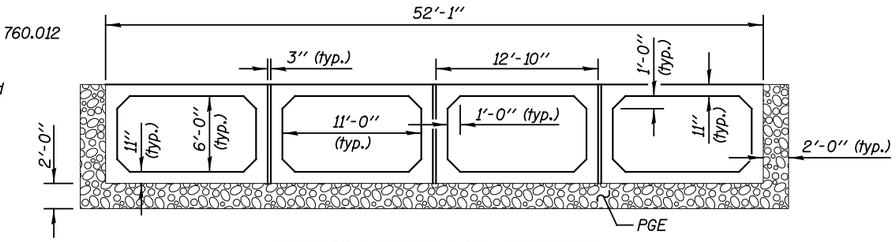
Bench Mark: 89° 04′ 16.59245" W 42° 12′ 33.05440″ Cut Sq; W Edge of old sign foundation E of E Frontage Rd - Northeast corner IL 251 & Samuelson; Elev. 760.012

Existing Structure: The existing bridge structures numbered 101-0009 and 101-0010 are reinforced concrete slab bridges originally constructed in 1951 and reconstructed in 1985. Structure Numbers 101-2001 and 101-2002 are three (3) celled reinforced concrete box culverts and were constructed in 1958 with no work since.

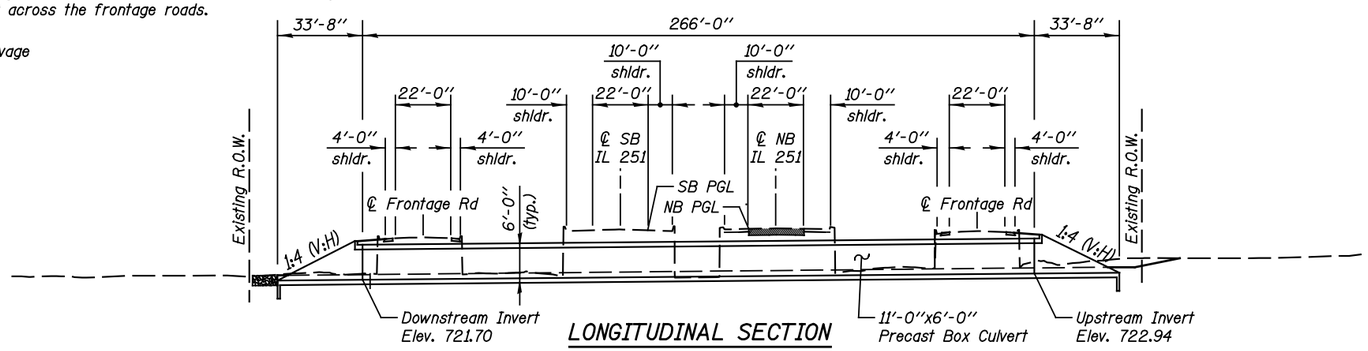
Proposed Structure: The proposed structure number 101-2050 will be a 266′ long (4) 11′x5′ precast concrete box culvert that will replace all four (4) of the existing structures and will extend across all four (4) roadways, medians and shoulders.

Staging: During construction one lane of traffic in each direction will be maintained on the northbound lanes for Stage I, and will be moved to the southbound lanes for Stage II construction. Road closures will be provided for the construction of the culvert across the frontage roads.

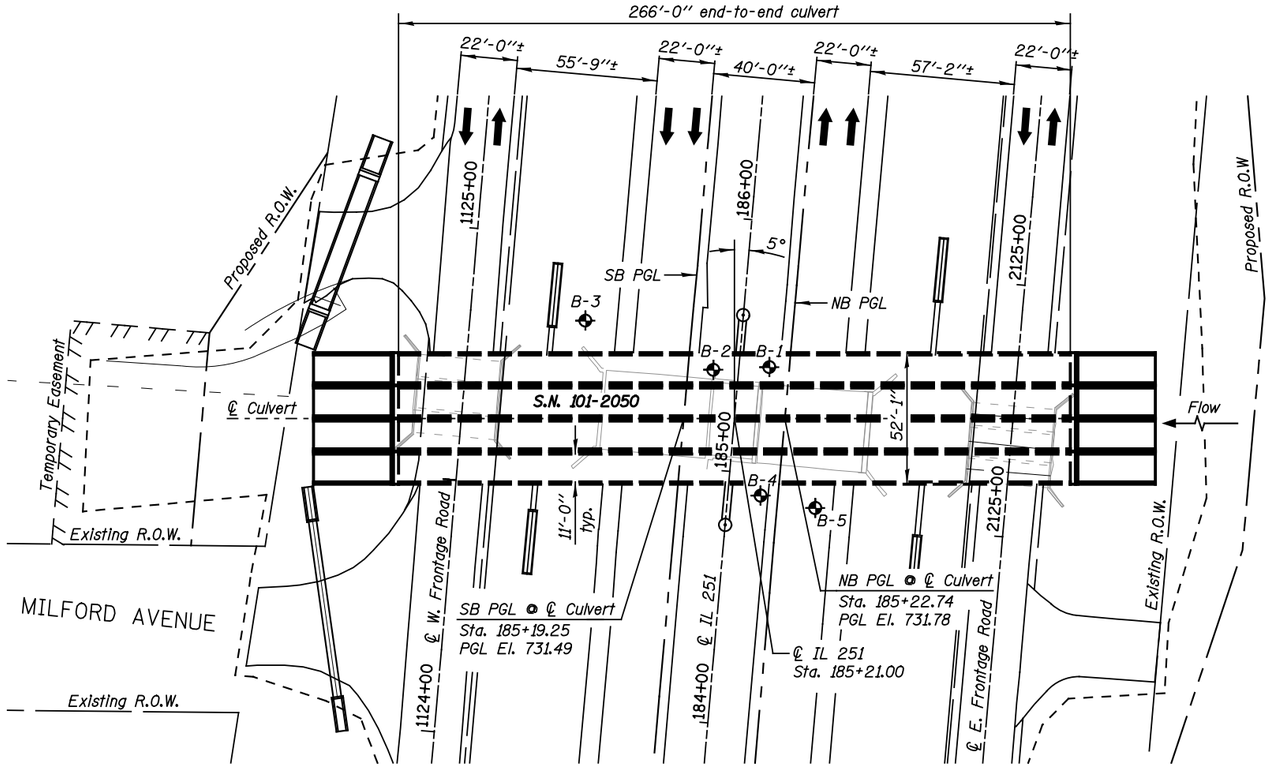
No Salvage



SECTION THRU BOX CULVERT



LONGITUDINAL SECTION



PLAN

HIGHWAY CLASSIFICATION

F.A.U. Route 5128 (IL 251)
Functional Class: Minor Arterial
ADT: 12,470 (2015); 14,000 (2035)
DHV: 1400 (2035)
ADTT: 5%
Design Speed: 55 mph
Posted Speed: 55 mph
Directional Distribution: 50:50(NB:SB)

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.080g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.135g
Soil Site Class = D

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition, with 2015 & 2016 Interim Revisions

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

PRECAST UNITS

f'_c = 5,000 psi
f_y = 65,000 psi (welded wire reinforcement)

Legend

Soil Borings
F.F. Front Face
B.F. Back Face

WATERWAY INFORMATION

Drainage Area = 37.7 Sq. Mi.

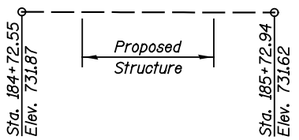
Exisitng Low Grade Elev. 731.41 @ Sta. 188+45
Proposed Low Grade Elev. 731.41 @ Sta. 188+45

Flood	Freq. Yr.	Q C.F.S.		Opening Sq. Ft.		Nat. H.W.E.	Head - Ft.		Headwater El.	
		Exist.	Prop.	Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
Main Channel #1	10	480.95	-	31.7	31.7	727.52	0.02	0.01	727.54	727.53
Relief Structure #2		85.33	-	22.8	22.8	727.52	0.02	0.01	727.54	727.53
Relief Structure #3		139.71	-	96.9	147.0	727.52	0.02	0.01	727.54	727.53
Total		705.99	706	-	-	-	-	-	-	-
Main Channel #1	50	814.97	934.8	35.2	35.2	727.81	0.55	0.08	728.36	727.89
Relief Structure #2		196.38	130.07	26.3	26.3	727.81	0.55	0.08	728.36	727.89
Relief Structure #3		244.65	191.05	105.3	159.7	727.81	0.55	0.08	728.36	727.89
Total		1256	1256	-	-	-	-	-	-	-
Main Channel #1	100	1031	1165	36.6	36.6	727.93	1.14	0.33	729.07	728.26
Relief Structure #2		250	180	27.7	27.7	727.93	1.14	0.33	729.07	728.26
Relief Structure #3		30	236	108.8	165.0	727.93	1.14	0.33	729.07	728.26
Total		1581	1581	-	-	-	-	-	-	-
Main Channel #1	500	1915.25	2273.65	42.6	42.6	728.43	2.69	2.42	731.12	730.85
Relief Structure #2		850.65	582.75	33.7	33.7	728.43	2.69	2.42	731.12	730.85
Relief Structure #3		508.113	417.6	81.5	187.0	727.43	2.69	2.42	731.12	730.85
Total		3274.01	3274	-	-	-	-	-	-	-

10-Year Velocity through Existing Bridge = 3.1 fps
10-Year Velocity through Proposed Bridge = 4.84 fps

PRECAST BOX CULVERT SCHEDULE (ASTM C 1577)

Station	Size (Span x Height)	Design Fill (ft.)		PGE Backfill Required
		Edge of Shldr. (min.)	Maximum	
185+21	(4) 11′ x 6′	1′	2.6′	Yes

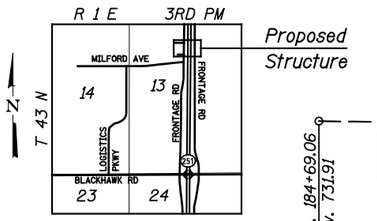


PROFILE GRADE LINE

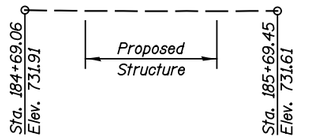
Northbound IL 251

DESIGN SCOUR ELEVATION TABLE

Design Scour Elevation (ft.)	Upstream	Downstream
	719.51	717.96



LOCATION SKETCH



PROFILE GRADE LINE

Southbound IL 251

GENERAL PLAN
IL 251 OVER UNNAMED DITCH
F.A.U. RTE. 5128
SEC. 105RS-6 & 105BR-1
WINNEBAGO COUNTY
STA. 185+21
STRUCTURE NO. 101-2050

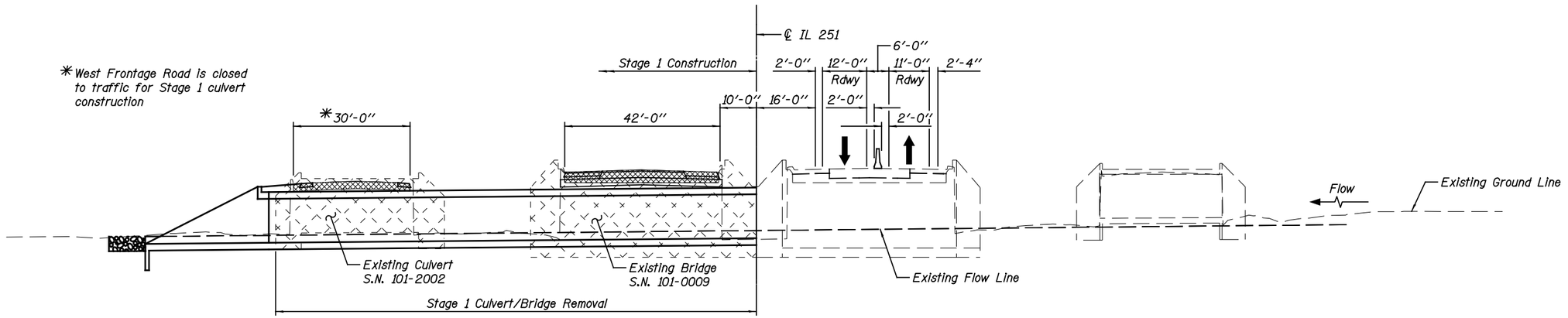
KNIGHT Engineers & Architects

		DESIGNED - FW	REVISED
		CHECKED -	REVISED
SCALE - NONE		DRAWN - DC	REVISED
DATE - 3/29/2016		CHECKED - FW	REVISED

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

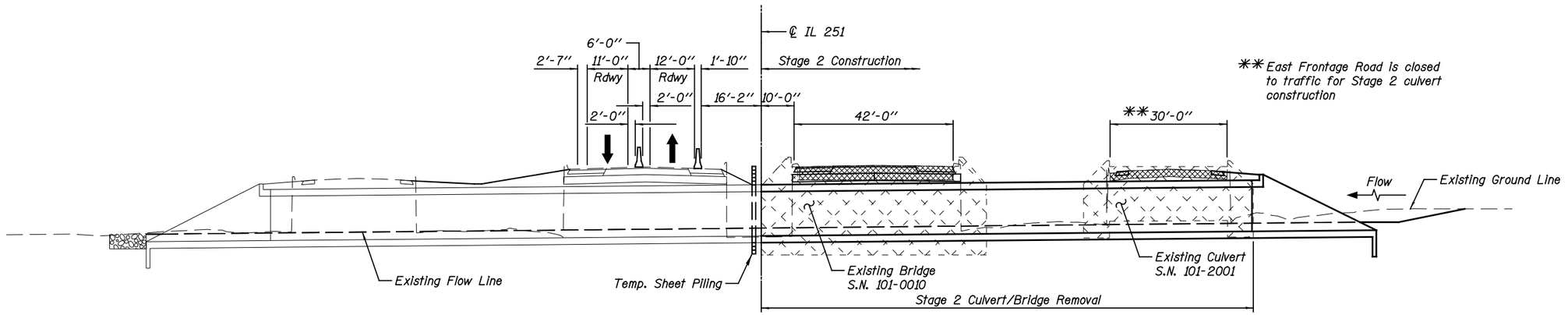
SHEET NO. 1 OF 1 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
5128	105BR-1	WINNEBAGO		
		CONTRACT NO. 64D70		
		ILLINOIS FED. AID PROJECT		



STAGE 1 CULVERT SECTION

Looking North



STAGE 2 CULVERT SECTION

Looking North

STAGING
IL 251 OVER UNNAMED DITCH
F.A.U. RTE. 5128
SEC. 105RS-6 & 105BR-1
WINNEBAGO COUNTY
STA. 185+21
STRUCTURE NO. 101-2050

KNIGHT
Engineers & Architects

	DESIGNED - FW	REVISED	
	CHECKED -	REVISED	
SCALE - NONE	DRAWN - DC	REVISED	
DATE - 3/29/2016	CHECKED - FW	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. 2 OF 2 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
5128	105BR-1	WINNEBAGO		
		CONTRACT NO. 64D70		
	ILLINOIS	FED. AID PROJECT		